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ABSTRACT

High school mathematics teachers were trained to provide mastery learning instruction. A primary characteristic of this method of instruction is the feedback-corrective enrichment loop. This study was conducted to determine whether class time could be allocated for the principles of mastery learning within the fixed amount of available time without placing one group of students at a disadvantage while increasing the instruction for others. The teacher training program emphasized improving the ability to understand the principles of mastery learning and increasing the opportunities for learning effective classroom management strategies. The training activities incorporated staff development practices which would increase the likelihood that teachers would implement the instructional strategies presented. Results of the study indicated that teachers who participated in the staff development program made greater use of the feedback-corrective enrichment loop in their classroom lessons. Teachers and students utilized available instruction time more purposefully. This study does not support Marshall Arlin's contention that group based mastery learning programs deprive the academically rich to provide corrective instruction for the academically poor. (DWH)

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Group-Based Mastery Learning: A Robin Hood Approach to Instruction?

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GROUP-BASED MASTERY LEARNING: A ROBIN HOOD APPROACH TO INSTRUCTION?

The challenge of providing high quality group instruction that can address students' individual learning needs has been the focus of research on mastery learning for more than a decade (Block 1974, 1979; Block and Anderson 1975; Bloom 1968, 1976, 1981, 1984; Guskey 1980, 1981, 1984). The results of these research and development efforts have provided compelling evidence of the positive impact the learning-for-mastery process has on student achievement, and increasingly schools across the country are exploring ways they can provide their students with the benefits of mastery learning instruction.

The primary characteristic of mastery learning instruction that distinguishes it from conventional instruction is the feedback -corrective/enrichment loop. This component is not typically present in conventional instruction. The feedback-corrective/enrichment loop includes formative testing to assess student progress, followed by alternative learning activities. Corrective activities are assigned to students in need of remedial assistance, as determined by their performance on the formative test, while enrichment activities are provided to students who demonstrate a mastery level of performance. These enrichment activities are designed to extend students' learning by directing them to use higher level thinking skills and by engaging them in related activities that enhance the meaning of the lesson.

Two recent reviews of the teacher effectiveness literature support the importance of this instructional component. In their meta-analysis of the research on instruction, Lysakowski and Walberg (1982) found that the mean achievement score of students receiving corrective feedback falls at the 83rd percentile of learning on control group distributions. In addition,

Rosenshine (1983) included three functions directly related to the feedback-corrective loop among the six major instructional functions he identified in his analysis of the teacher effectiveness research. They are,

-- Review, checking previous day's work, and reteaching if necessary

-- Initial student practice and checking for understanding

-- Feedback and correctives, and reteaching if necessary

Although the research on instructional effectiveness has consistently underscored the importance of the feedback-corrective/enrichment loop, the most practical means of providing a sufficient amount of time for both corrective and enrichment activities, in addition to other instructional activities, within a fixed amount of class time have not been identified through these research efforts. Moreover, Cohen (1984) has suggested that allocating instructional time for corrective learning activities presents an ethical dilemma for the classroom teacher. He warns that the price of setting aside class time for remedial learning activities within a group-based instructional format is often paid by placing limits on the learning opportunities for more talented students. Similarly, Slavin and Karweit (1984) have speculated that the benefits of corrective instruction may be diminished by the cost of taking time away from instruction to the class as a whole. They have recommended that studies be conducted to determine effective and efficient strategies to assist all students in achieving a mastery level of performance within the scheduling and resource constraints typical of elementary and secondary classrooms.

One of the few studies of group-based mastery learning that has directly investigated the issue of time allocation for the feedback-corrective/enrichment loop was conducted by Arlin (1982). He examined the implementation of the principles of mastery learning by

twenty-eight elementary teachers who volunteered to attempt a mastery learning pilot project in their classrooms.

The teachers participated in a two-day workshop on constructing mastery units, objectives, and quizzes, and were given access to literature describing the principles of mastery learning. They were then allowed six weeks to develop a mastery learning module. Following this brief introduction to mastery learning, eleven teachers reported that the project was too time consuming and terminated their participation. Arlin observed the classes of the remaining seventeen teachers to determine their implementation of mastery learning procedures. On the basis of those observations and follow-up discussions with the teachers, he decided that only ten of the teachers adhered sufficiently to mastery learning procedures to warrant further observation. Consequently, his research findings were based upon his subsequent study of these ten teachers.

Two major sets of findings resulted from Arlin's study. The first finding concerned where teachers obtain extra time to provide corrective learning activities for "slower" learners. Arlin stated,

> The solution most teachers adopted was to make the lessons shorter than originally planned so that they could have considerable time left in the class period to include at least one remedial session and retest. Usually students who needed additional remedial sessions were seen by the teacher during recess or lunch, a practice that was not likely to be received favorably over a long period of time.

The second finding concerned allocation of instructional time for "faster" students. Arlin reported,

> Many teachers originally planned enrichment work for the faster students, such as more advanced work on the topic under consideration... (They) eventually gave up assigning enrichment and allowed activities such as free reading, work in other subjects, trips to the library, or quiet socializing at the back of the room. Cooperation of faster students took precedence over further depth, and particularly over further breadth. The major concern with faster students did not seem to be with enrichment but with the managerial requirement to

keep them occupied.

Arlin (1984) characterized this neglect of faster students as a Robin Hood approach to instruction, since teaching time was taken from the academically rich (the faster students) to provide additional time for the academically poor (the slower student).

In a critique of Arlin's study, Block (1983) offered several suggestions for how research on instructional time costs of mastery learning could be strengthened:

> ...Time allocation studies might use teachers better "grooved" in the use of mastery learning ideas; spread out the length of the treatment and cut the number of feedback/correction points; ensure that the correctives are better tailored to the teachers' original lesson plans; take steps to teach students how to use each corrective before the teaching begins; design the enrichments in a more systematic less busy work fashion; and make greater use of a combination of in class, in school/outside of class, and out of school time.

Design of Study

The present paper describes a study that incorporated Block's recommendations. The study is part of a larger project, currently in progress, that is investigating several policy issues and leadership functions related to the instructional improvement process. One component of the project involved training high school mathematics teachers in the application of mastery learning procedures. The training program also included classroom management strategies found to be related to higher rates of student academic engaged time (Anderson, Evertson and Brophy 1978; Berliner, Fisher, Filby, and Marilave 1978; Emmer and Evertson 1980, 1981; Fitzpatrick 1982; Good and Grouws 1978; Stallings 1980). The classroom management and organizational strategies discussed in the training program were presented within two categories: namely, those strategies that help establish an effective classroom management system (e.g., establishing clear

expectations and consequences for student behavior, minimizing interruptions of class time, and maintaining an academic focus), and those strategies that help sustain the system (e.g., monitoring student performance, providing smooth transitions between instructional activities, holding students accountable, and establishing a positive climate for learning).

The design of the staff development activities was based on the research on effective staff development practices (Bauchner and Loucks 1982; Gersten and Carnine 1981; Joyce and Showers 1982; Lieberman and Miller 1981; Little 1982; Loucks 1983; Sparks 1983; Stallings 1981, 1983). These research findings suggest a pattern of effective training practices that can be characterized as a mastery learning model of staff development. The aim of these staff development practices is not only to present research-based instructional strategies to the teachers, but also to assist them in applying these strategies to their actual classroom instruction.

Procedures

The staff development program included four major sets of activities: a five-day summer seminar, three monthly follow-up sessions during the first semester of the following academic year, peer observations and coaching, and an administrators' seminar. Throughout the training program, the participants were given opportunities to specify the objectives of each lesson, to design formative tests, to develop corrective and enrichment activities tailored to their instructional objectives, and to exchange teaching ideas with each other both in team planning sessions and through peer observations.

Sample

Forty secondary school mathematics teachers from six school districts in suburban Chicago communities participated in the study. The teachers, who participated voluntarily, were randomly assigned by school to the treatment and control conditions. Twenty-one teachers participated in the training program during the summer and fall of 1984. The control group will receive similar training in the summer and fall of 1985.

Research Questions

The purpose of the present study was to investigate the extent to which the teachers who participated in the training program actually implemented the mastery learning approach to group-based instruction. The following research questions were posed:

1. Will those teachers who participate in the training program apply the recommended teaching strategies presented in the program? (Specifically, will they incorporate the feedback-corrective/enrichment loop in their instruction?)

2. If the feedback-corrective/enrichment loop is incorporated within the teachers' instruction after they received training, where was class time shifted to accommodate this instructional component?

Data Collection

Teachers in both the treatment and control groups were observed on a pre-post basis. During the spring of 1984, one class of each of the teachers was observed for five consecutive days, and the observation cycle was repeated twice during the first semester of the 1984-85 academic year. The first post observation occurred between the first and second follow-up session, whereas the second observation was conducted two weeks after the second follow-up session. Each observation cycle was initiated at the beginning of a unit of instruction.

The classroom observation instrument was designed to assess the amount of class time allocated to various instructional functions: reviewing and correcting homework; presenting new concepts and skills; providing opportunites for students to practice new skills and concepts; conducting formative assessments of students' progress; helping students complete corrective and enrichment learning activities; directing students to independently complete practice exercises; and administering quizzes. In addition, the instrument was used to record the amount of class time spent in transition between instructional activities and in nonacademic interaction. Observers coded the occurrence of these events at one-minute intervals throughout the instructional period. At five-minute intervals they recorded the number of students who were off-task.

Certified secondary school teachers currently working on a substitute basis served as classroom observer. They were trained in April 1984 and participated in a retraining session in September 1984. The extent of agreement among the observers at the conclusion of each training session was determined to be .90 and .84, respectively.

Results

The first research question posed in the study called for an analysis of the extent to which the teachers incorporated the feedback-corrective/enrichment loop within their lessons. To answer this question, an average distribution of time allocated to the six instructional functions was calculated for each teacher over the five pre- and ten post-observation periods, adjusted for differences in the number of minutes of classroom observation. These averaged percentages of time became the frequencies on which statistical analyses were conducted. Table 1 reports the distributions further standardized by the number of teachers in the treatment and control

groups (21 and 19, respectively).

Table 1
Percentage of Class Time Allocated to Six Instructional Functions
In Pre- and Post-Observations, by Group
(Standardized Per Teacher)

Instructional Function	Treatment Group Pre	Treatment Group Post	Control Group Pre	Control Group Post
Feedback-Corrective/ Enrichment Loop	.1	21.0	.7	.3
Transition/Non-Academic Interaction	12.0	8.5	13.4	11.3
Review/Correcting Homework	42.9	28.1	31.3	35.8
Quiz	6.4	7.8	5.9	10.3
Development/Guided Practice	27.9	29.1	27.0	21.9
Independent Practice	10.7	5.5	21.7	20.4
Total (Sum of Frequencies)	100 % (2100)	100 % (2100)	100 % (1900)	100 % (1900)

Inspection of the percentages reveals that the occurrence of the feedback-corrective/enrichment loop was extremely rare among both control group and treatment group teachers prior to the training period. Following the training program, however, the trained teachers on average allocated about 20 percent of class time to this instructional component. Since the training effect, as indicated by these data, was so great, the calculation of a statistical test was needless. Furthermore, the aggregated percentages in the table disguise the fact that the large majority of the teachers implemented the instructional principles presented in the training program. Of the 21 teachers who received the training, all but three allocated at least 10 percent of their class time to the feedback-corrective loop following the training program.

Since these findings indicate that the teachers in the treatment

group devoted a considerable amount of class time to the feedback-corrective/enrichment function after they had participated in the training program, whereas they had devoted virtually no time to it prior to the training program, it was of interest to determine how they had distributed class time across the other instructional functions to accommodate this change. The data in Table 1 suggest that declines were greater in some functions than in others, rather than occurring evenly across all five. Table 2 provides a more direct display. Percentages were recalculated from the frequencies for each of the instructional functions, excluding the feedback-corrective/enrichment loop. A significant Chi-square computed for the 2 x 5 contingency table (64.788, 4 df) leads to rejection of the hypothesis that the pre and post distributions were alike.

Table 2
Change in Time Allocations to Five Instructional Functions in Treatment Group

Instructional Function	Pre	Post	Change
Transition/Non-Academic Interaction	12.0	10.7	-1.3
Review/Correcting Homework	43.0	35.6	-7.4
Quiz	6.4	9.8	3.4
Development/Guided Practice	27.9	36.8	8.9
Independent Practice	10.7	7.1	-3.6
Total (Sum of Frequencies)	100 % (2098)	100 % (1659)	

The analysis of the differences between the distributions of class time across the various instructional functions indicates that following the training program the teachers allocated significantly more time to presenting and developing lessons and to administering quizzes, whereas they spent considerably less time reviewing and correcting homework and allowing

students independent practice. They also spent less time engaged in nonacademic interactions and transitions between instructional events, although this difference was not as great as the others.

Lastly, the data collected through the classroom observations provided the opportunity to compare rates of off-task behavior among students of the trained and untrained teachers. Table 3 shows the average incidence of off-task behavior in the 21 treatment and 19 control classrooms (corrected for differences in numbers of students) in the pre and post observation periods. While the means of the two groups were quite similar in the pre observations, they differed substantially after the one group had received training. The rate of off-task behaviors declined markedly in the treatment group, although they also declined slightly in the control classroom.

Table 3
Pre and Post Means of Off-Task Behavior
in Treatment and Control Classrooms

Group	(N)	Mean	S.D.	Mean	S.D.	Adjusted Post
Treatment	(21)	13.4	6.53	6.0	3.91	6.67
Control	(19)	16.8	12.72	14.2	8.30	13.42

Since the incidence of off-task behaviors was found to be rather strongly correlated in the 40 classrooms between pre and post observations (r = .56), an analysis of covariance was performed on the data, using the pre observation incidence as the covariate. The post means adjusted for the pre means are also shown in Table 3. The difference between the groups on the adjusted means was significant beyond the .001 level by the F test (F = 16.611. 1/37 df).

Correlations between the pre and post incidence of off-task behaviors

for the two groups separately, however, showed a coefficient of .69 for the control classrooms and only .14 for the treatment classrooms. A test for homogeneity of slopes of the regression lines yielded an F ratio of 3.280, nearly significant at the .05 level ($p < .078$, 1/36 df), raising the possibility that the effects of training and/or alteration in the instructional design were more complex than merely enhancing the general level of student attention and interest. Examination of the scattergram for the treatment group indicated that the greatest declines in off-task behavior occurred in the classrooms of those teachers who initially experienced the highest incidence of student off-task behaviors.

One possible explanation for this outcome may be that the teachers who initially had to contend with higher rates of student off-task behaviors may have considered their students' behavior to be a serious barrier to their instructional effectiveness, and consequently may have applied the classroom management strategies presented in the training program in a more systematic fashion.

Another possible reason for this difference in the rate of decline in off-task behaviors may be related to the effect of the learning-for-mastery process on student learning skills. The findings of a study conducted by Hecht (1977) indicated that students acquire and/or further develop learning-to-learn skills in mastery learning instructional programs. Possibly those students who demonstrate the highest rates of off-task behaviors can also be characterized as those who approach their studies without a clear sense of purpose. Perhaps as these students become more proficient at applying learning skills and begin to take on greater responsibility for their academic performance under the mastery learning approach to instruction, they may also begin to view their off-task behaviors as an obstacle to their academic success and to place a greater value on

instructional time.

Discussion

The results of this study clearly indicate that the teachers who participated in the staff development program made much greater use of the feedback-corrective/enrichment loop in their lessons. Furthermore, the findings suggest that both the teachers and students utilized the available time for instruction more purposefully, since the amount of time spent in transitions between instructional events and in non-academic interaction was decreased by one-third, and the rate of student off-task behaviors was diminished by more than one-half.

The findings that pertain to teachers' allocation of time for various instructional functions are of particular interest. For example, the time allocated to independent seatwork decreased by almost one-half, suggesting that more of the teachers' time was spent during the instructional period in substantive academic interaction with the students, rather than simply monitoring their work. Also, instructional time spent reviewing and correcting homework was decreased by one-third. These results seem to suggest that rather than spending class time in an overall review of previous lessons and correcting homework exercises, the teachers were able to focus the lesson during the corrective learning activities on specific concepts or skills the students required assistance with, as identified through formative assessments of their progress. Consequently, these teachers may have been able to tailor their lessons to the learning needs of their students.

In addition, the results indicated that significantly more time was spent in presenting and developing new material and administering quizzes after the teachers participated in the training program. Thus, both of these functions appear to have taken on greater priority, in terms of allocated

time.

Lastly, it is important to note that the teachers reported they had covered the same amount of material in their classes at the end of the first semester after the training program as they had in prior years. Hence, the teachers' applications of the chief principle of mastery learning, the feedback-corrective/enrichment loop, does not appear to have slowed down the pace of their courses.

The findings of this study differ in several respects from those reported by Arlin (1982). For example, Arlin found that the teachers shortened the presentation and development of their lessons so that they could provide feedback to students on their learning progress and involve them in corrective learning activities. However, in the present study the teachers allocated significantly more time to the initial presentation of each lesson.

Secondly, Arlin reported that the teachers in his study met with the students who needed additional remedial assistance during recess and lunch time. He noted that the teachers considered this to be an excessive burden on their time and speculated that they would discontinue this practice shortly after the pilot project was completed. In contrast, the findings of this study indicate that a significant amount of time was provided within the allocated class time for the feedback-corrective loop.

Lastly, in Arlin's study the teachers' primary concern regarding the "faster" students was to simply keep them busy, rather than provide them with instructional activities to enrich their learning. Furthermore, he reported that the teachers diminished the availability of learning opportunities for the faster students, while the amount of instruction for the slower students increased. Contrary to these findings, the results of the present study indicate that neither the pace of instruction nor the amount of time

allocated to the presentation and development of each lesson were adversely affected by the teachers' application of mastery learning principles. Since there was no difference in the amount of material covered before and after the training, it would appear that the teachers did not alter the scope of instruction to accommodate the learning-for-mastery process. Furthermore, in some cases these teachers provided opportunities for their students to pursue the learning objectives at a greater depth of understanding following the training program, although these opportunities were not evident prior to the program. Hence, it seems that the approach to instruction they employed was not consistent with the "Robin Hood" philosophy Arlin characterized, since neither the breadth nor the depth of instruction was diminished after the teachers began to apply mastery learning procedures.

The differences in the findings of this study and those of Arlin's can possibly be attributed to two key factors in the design of the training program developed through this study. First, in addition to the principles of mastery learning, the content of the program included research-based classroom management and organizational strategies found to promote higher rates of student academic engaged time. Research findings on classroom management have consistently indicated that without an effective classroom management system that holds students accountable to a clear set of academic and behavioral expectations and establishes an environment conducive to learning, the most thoughtfully and carefully designed lessons will fail to be as effective as they would have been otherwise (Evertson and Emmer 1982).

Furthermore, as Slavin (1984) noted in his analysis of Carroll's (1963) model of school learning, there are four components among the elements of the model that are primarily under the control of the teacher or school, and thus can be considered as alterable elements of instruction. The four alterable components Slavin identified include appropriate levels of

instruction, incentives, time, and quality of instruction. Two of these components are addressed in the research on mastery learning and the research on effective classroom management strategies. Specifically, the principles of mastery learning are directly aimed at providing appropriate levels of instruction and improving students' abilities to understand, whereas the research on effective instructional strategies that promote higher rates of student academic engaged time are focused on utilizing the available time for instruction to the best advantage.

The purpose of the present study was to determine whether or not class time could be allocated for the principles of mastery learning within the fixed amount of available time without placing one group of students at a disadvantage while increasing the benefits of instruction for others. Therefore, the selection of the content of the training program reflected a combination of the findings from the research on effective instructional practices aimed at two of the alterable elements of Carroll's model--namely, improving the ability to understand (the principles of mastery learning) and increasing the opportunities for learning (effective classroom management strategies).

The second major distinction between the design of Arlin's study and the present study is related to the training activities that were provided. The training activities included in this study were modeled after those found to be effective through the research on staff development. This area of research has provided a considerable amount of evidence that one-shot approaches to staff development, where teachers are given little or no support, and are given neither follow-up assistance nor opportunities for collegial planning, result in low levels of implementation, both in quality and duration (Coladarci and Gage 1984; Fullan and Pomfret 1977; Gall 1982; Joyce and Showers 1980; Lieberman and Miller 1981; Loucks 1983; Sparks 1983).

Thus, the design of the program's training activities incorporated those research-based staff development practices that increase the likelihood that the teachers would implement the instructional strategies presented in the program.

In addition to the teacher-training components of the staff development program, a seminar was held for the administrators of the schools participating in the program. During the seminar, suggestions were offered for ways the administrators could support the teachers implementing the recommended instructional strategies. The support strategies presented to the administrators were drawn from the research on effective schools. In particular, the strategies that were discussed in the seminar included the administrative support functions outlined by Gersten and Carnine (1981), the instructional leadership behaviors linked to the characteristics of effective schools identified by Russell and White (1984), the administrative behaviors related to instructional improvement noted by Loucks and her colleagues (Bauchner and Loucks 1982; Loucks and Zacchei 1983) in their studies of the dissemination process, and the leadership functions that facilitate the implementation and effectiveness of staff development programs identified by Gall and his associates (1984).

In short, the training program was deliberately designed to provide the teachers with both direct and indirect sources of support. Direct support was offered through the program activities provided to them. In addition, the program indirectly supported their efforts to improve instruction by helping to establish a common language between the administrators and the teachers concerning effective instructional practices, and by highlighting ways to strengthen their partnership in the instructional improvement process.

On the basis of the interpretation of his findings related to the

allocation of instructional time in group-based mastery learning program as a Robin Hood approach to instruction, Arlin (1984) has advanced the notion of establishing a predetermined level for both the pace and the rigor of group instruction. He has suggested that this level of instruction for a class should be set somewhere near the middle of the range of the students' individual learning rates. Arlin refers to this practice as "collective leveling" and argues that it provides an expedient pedagogical strategy for pacing students who learn at diverse rates. He states,

> "...collective leveling functions as an unconscious means to establish an equilibrium between the apparently conflicting ideals of equal time and equal achievement amid the pervasive background of individual differences. ...As with most compromises, all good things are not maximized. Student achievement outcomes are not equal, but they are less unequal than they might be if faster students were provided time more appropriate to their abilities."

As noted earlier, the findings of this study do not support Arlin's contention that group-based mastery learning programs necessarily steal from the academically rich to provide corrective instruction for the academically poor. Nor do the findings lend credence to the appropriateness of the collective leveling compromise. This can perhaps be best illustrated in the reflections that the teachers shared with each other at the final session of the training program. Many reported that they have set a goal for themselves in their future applications of mastery learning--to provide a greater range of enriched learning activities for their students. In their ongoing efforts to resolve the dilemma of providing group instruction for students with diverse needs in a fixed amount of time, these teachers have chosen to focus their energies on maximizing the talent of their students, instead of concerning themselves with establishing a manageable level for student achievement. To borrow from Arlin's analogy, they are committed to finding more effective ways to help the rich become even richer. Their perspective

on the challenge to provide high quality group instruction for their students is hopeful, and, at least for them, the collective leveling compromise is a trade-off they are not willing to make.

Additional research on the alterable components of Carroll's (1963) model of school learning is needed. In particular, the design of future studies should take into account the research findings of Slavin (1980, 1981, 1983a, 1983b, 1984) on increasing student incentives and motivation for learning through cooperative team work, along with the results of the research on mastery learning and classroom management. Also, it should be noted that the findings of this study can be generalized only to a similar sample (high school mathematics teachers). Additional studies need to be conducted that include instructional programs on a variety of grade levels and content areas. Whether or not staff development programs that combine training on classroom management strategies and the instructional principles of mastery learning are an effective means for improving instruction in other content areas or at different grade levels has yet to be determined.

In addition, further research is needed to examine the context of the instructional improvement process. The findings from the research on instructional improvement through staff development have begun to outline several practices that facilitate the implementation of effective instructional strategies. For example, one of these practices calls for providing the opportunity for teams of colleagues to work together in strengthening the instructional program. Yet, particularly in secondary schools, it is often the case that teachers experience a high degree of isolation in their work, due in part to the fragmentation of most high school curricular programs. In many ways these conditions within the school preclude the opportunity for collegial teamwork. Additional research is needed to explore the range of implications of the research on effective

staff development practices that are related to the organizational framework of the school and to the policies that shape key decisions affecting the improvement process. Clearly, advances in our understanding of effective instructional practices will not lead to comparable gains in student learning unless thoughtfully designed staff development programs are provided to assist teachers in applying these teaching strategies, and until school policies are adopted that expand, rather than restrict, the capacity of the school to improve its instructional program.

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